

IAEA Review of Safety Related Aspects of Handling ALPS-Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station

**Report 4: Review Mission to TEPCO and METI
(November 2022)**



IAEA

International Atomic Energy Agency

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**IAEA Review of Safety Related Aspects
of Handling ALPS Treated Water
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Published by the International Atomic Energy Agency in April 2023

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Executive Summary

The IAEA conducted its second review mission to Japan's Tokyo Electric Power Company Holdings, Inc. (TEPCO) and the Ministry of Economy, Trade and Industry (METI) in 14–18 November 2022. The first review mission focused on TEPCO and METI was held 14-18 February 2022. The mission was conducted under the terms of reference for the IAEA's assistance to Japan on the Review of Safety Aspects of ALPS (Advanced Liquid Processing System) Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station (FDNPS) and formed part of the review component relating to the assessment of protection and safety. The review team, coordinated and led by a senior IAEA official, included 15 members. The review team was comprised of experts from the IAEA Secretariat and international experts who are designated members of the Task Force.

Consistent with the request from the Government of Japan, the IAEA statutory functions and the mandate of the Task Force, the scope of the IAEA review is tailored to assessing safety related aspects of the implementation of Japan's *Basic Policy on Handling of ALPS Treated Water at the Tokyo Electric Power Company's Holdings' Fukushima Daiichi Nuclear Power Station* against the IAEA's International Safety Standards¹. The current approach outlined in the Basic Policy is to conduct a series of controlled discharges of ALPS treated water into the sea over a period of approximately 30 years. This mission was conducted focusing on the specific approach outlined in the Basic Policy, controlled discharge to the sea, consistent with the request from the Government of Japan.

To implement this approach, TEPCO has proposed amendments to its Implementation Plan (i.e. its regulatory authorization to conduct decommissioning activities), including conducting a safety assessment and developing a radiological environmental impact assessment (REIA). The mission scope covered: the proposed discharge system and process equipment, the tanks containing ALPS treated water that will be connected to the discharge system (i.e. K4 tank group), the associated operational and engineered safety controls, the safety assessment of the discharge including a prospective REIA conducted by TEPCO, and the radiation protection programme established and maintained by TEPCO. In general, the site's comprehensive decommissioning activities were considered outside the scope of this mission and the IAEA's overall safety review.

The review against the relevant IAEA International Safety Standards was organized into the following eight technical topics:

1. Crosscutting requirements and recommendations
2. Characterization of discharge/source term
3. Safety related aspects of systems and processes for controlling discharges
4. Radiological environmental impact assessment (REIA)
5. Regulatory control and authorization for discharges
6. Source and environmental monitoring programmes
7. Involvement of interested parties
8. Occupational radiation protection

Between the first and second missions to TEPCO and METI significant progress was made by TEPCO during which the domestic regulatory review continued. The Task Force's observations from the first mission were considered and reflected in revisions to key documents such as the Implementation Plan, and in particular the REIA. The most recent Implementation Plan updates occurred in April, May, and July 2022, which the Task Force reviewed. These served as the main source of information for the Task Force to identify questions and technical topics for further discussion with TEPCO and METI. During

¹ The International Safety Standards established by the IAEA constitute the global reference for protecting people and the environment. They contribute to a harmonized high level of safety worldwide. The process of developing, reviewing, and establishing the IAEA standards involves the IAEA Secretariat and all IAEA Member States. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned.

the mission, TEPCO provided presentations for each of the eight technical topics listed above, with a focus on responding to specific questions and comments from the Task Force shared prior to this mission. TEPCO submitted additional revisions to the Implementation Plan and REIA in November 2022 and again in February 2023 as part of progress in their domestic regulatory review/However, these revisions could not be fully considered as part of this mission and the Task Force continues to assess the contents as part of its ongoing safety review.

During the mission, the Task Force received full cooperation from counterparts in TEPCO and METI and noted a commitment to the successful completion of the IAEA's review. Over the course of the week a wide range of technical topics were discussed, and the details of these discussions are included in Part II of this report. Several high-level observations from the Task Force are summarized as follows:

- Many Safety Requirements that are relevant to the IAEA's review are overarching and crosscutting in nature (e.g. governmental framework, responsibility for safety, optimization of protection and safety of workers and members of the public). The Task Force will continue addressing these crosscutting topics in different components of its review/However, the Task Force did not request any additional information from METI and TEPCO relevant to the requirements and recommendations included in the IAEA's International Safety Standards applicable to the review (see Appendix I). The Task Force will conclude whether the fundamental safety principles have been addressed by TEPCO at the end of the full review once all other topics have been closed. This will be documented in the comprehensive report prior to the discharge of ALPS treated water.
- Based on the information presented by TEPCO during this mission and extensive discussion, the Task Force had an overall view that the revised methodology for characterizing the source term is sufficiently conservative yet realistic. The Task Force identified that they may have further questions and comments on the detailed methodology used by TEPCO following a more detailed review of the November 2022 version of the REIA. Additionally, the Task Force notes that the revised source term presented to the Task Force during this mission is currently being reviewed by the NRA and could be subject to further revisions should NRA deem it necessary to meet domestic regulatory requirements. The Task Force will take into account the final, approved, source term as the IAEA's review continues.
- Regarding the REIA, the Task Force made a number of suggestions where further justification or explanation of the assumptions and methodology should be provided. In general, these remaining technical points will not prevent the IAEA from drawing conclusions regarding whether TEPCO is adhering to the relevant IAEA safety International standards. Rather, the Task Force has raised these points because significant discussion between the Task Force and TEPCO was required in order for the Task Force to fully understand the approach and assumptions made by TEPCO in a number of areas. In the interest of transparency, further explanation and additional clarity on these points would be helpful for interested parties to better understand the approach adopted by TEPCO.
- From the presentations made by TEPCO, the information made available to the Task Force during this mission, and the revised REIA, the Task Force better understands TEPCO's environmental monitoring programmes and agrees that it is comprehensive. During the meeting, the Task Force accepted the explanation and justification of the approach for which radionuclides will be monitored by TEPCO and included in the Comprehensive Radiation Monitoring Plan (CRMP), which focuses on the area around the discharge point.
- The Task Force is able to confirm that TEPCO has a reliable and sustainable radiation protection programme with the necessary commitment and ownership. The Task Force observed clear evidence of self-regulation by TEPCO for an advanced design and implementation of occupational exposure control measures and monitoring arrangements related to the operation of ALPS facilities and equipment.

No further missions to TEPCO and METI are needed prior to the issuance of the IAEA's comprehensive report. Remaining clarification or follow up will be handled through electronic communication.

This mission report reflects the discussions between the Task Force and Japan and documents observations from the Task Force. This report was written and approved by the IAEA Task Force and has been published by the IAEA on its public website. This report, and other mission reports under the IAEA's review, is intended to serve as a progress report and final conclusions will not be drawn while the IAEA's review is still ongoing. The IAEA will issue a comprehensive report in 2023 containing the conclusions of the Task Force across all aspects of the IAEA's review.

I. Part I

I.1. Introduction and Background

In April 2021, Japan announced the *Basic Policy on Handling of ALPS Treated Water at the Tokyo Electric Power Company's Holdings' Fukushima Daiichi Nuclear Power Station*, which includes a plan to discharge the treated water from the advanced liquid processing system (ALPS) into the sea surrounding the plant, subject to domestic regulatory approvals. Soon after, the Japanese authorities requested assistance from the IAEA to monitor and review those plans and activities relating to the discharge of the treated water to ensure they will be implemented in a safe and transparent way, and they will be in accordance with the IAEA's International Safety Standards². The IAEA, in line with its statutory responsibility, accepted the request made by Japan.

In July 2021, the IAEA and the Government of Japan signed the Terms of Reference for IAEA Assistance to Japan on Review of Safety Aspects of ALPS Treated Water at Tokyo Electric Power Company Holdings, Inc. (TEPCO) Fukushima Daiichi Nuclear Power Station (FDNPS). These terms of reference set out the broad framework that the IAEA will use to implement its review. In September 2021, the IAEA sent a team to Tokyo, for meetings and discussions to finalize the agreement on the scope, key milestones and approximate timeline for the Agency's review. The team also travelled to the FDNPS to discuss technical details with experts at the site and to identify key activities and locations of interest for the Agency's review.

The Agency's assistance to Japan will consist of a technical review to assess whether the operation to discharge the ALPS treated water over the coming decades is in accordance with the IAEA International Safety Standards. The IAEA will also undertake activities for the corroboration of the source and environmental monitoring programmes of TEPCO before, during and after the discharges. This review will be conducted on the basis of reference materials submitted by Japan and the outcomes of review missions. The IAEA will examine key safety elements of Japan's plan, including the following:

- The radiological characterization of the treated water to be discharged.
- The safety-related aspects of the treated water discharge process, including the equipment to be used and the criteria to be applied and observed for operations.
- The assessment of the radiological environmental impact related to ensuring the protection of people and the environment.
- The environmental monitoring associated with the discharge.
- The regulatory control, including authorization, inspection and ongoing assessment of the discharge plan.

The IAEA's review will be organized into the following three major components to ensure all key safety elements are adequately addressed:

- **Assessment of Protection and Safety** – This component is focused on reviewing technical aspects of the Implementation Plan, radiological environmental impact assessment (REIA), and other supporting materials prepared by TEPCO as part of their submission for regulatory approval of the discharge of ALPS treated water. This component will primarily be coordinated with TEPCO and the Ministry of Economy, Trade, and Industry (METI)³ and will look at the

² The International Safety Standards established by the IAEA constitute the global reference for protecting people and the environment. They contribute to a harmonized high level of safety worldwide. The process of developing, reviewing, and establishing the IAEA standards involves the IAEA Secretariat and all IAEA Member States. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned.

³ METI, as a government ministry, is the competent authority for overseeing the decommissioning of the FDNPS. Prior to the announcement of the Basic Policy, METI took a leading role in conducting studies for the handling of ALPS treated water. From this point of view, METI is included in the assessment of protection and safety component of the IAEA's review.

expected actions to be performed by TEPCO throughout the process, as defined in the relevant IAEA International Safety Standards.

- **Regulatory Activities and Processes** – This component is focused on assessing whether the Nuclear Regulation Authority’s (NRA) review and approval process is conducted in accordance with the relevant IAEA International Safety Standards. This component will primarily be coordinated with the NRA as the independent regulatory body for nuclear safety within Japan; it will focus only on the regulatory aspects relevant for NRA’s review of the discharge of ALPS treated water from the Fukushima Daiichi Nuclear Power Station.
- **Independent Sampling, Data Corroboration and Analysis** – This component includes all activities associated with the IAEA’s independent sampling and analysis that will be performed to corroborate the data from TEPCO and the Government of Japan associated with the ALPS treated water discharge. Samples will be analysed by IAEA laboratories as well as independent third-party laboratories. Additionally, this component also includes the corroboration of occupational exposure.

To implement the IAEA’s review in a fully transparent and inclusive manner, the IAEA Director General established a Task Force. The Task Force operates under the authority of the IAEA and is chaired by a senior IAEA official. The Task Force includes internationally recognized experts with extensive experience from a wide range of technical specialties and experts from the IAEA Secretariat. These experts will support the review and serve on the Task Force in their individual professional capacity to help ensure the IAEA’s review is comprehensive, benefits from the best international expertise and includes a diverse range of technical viewpoints.

The IAEA will conduct its review through a combination of the analysis of documentation, conducting review missions and performing other verification activities. At the start of the review, the Government of Japan, the NRA and TEPCO provided several background materials with information pertaining to the proposed discharge of ALPS treated water, including all laws and regulations relevant to FDNPS. Subsequently, additional materials have been provided upon request by the Task Force, or when ready for submission by TEPCO to the relevant Japanese authorities. This information is carefully reviewed by the Task Force members and forms the basis for the review missions with relevant authorities. The purpose of the review missions is to review the reference materials submitted by the NRA or TEPCO against the IAEA International Safety Standards, seek clarification on technical issues, request additional information and observe on-site activities, as appropriate. Additionally, to support the independent sampling and analysis activities, the Task Force will conduct discussions and on-site sampling activities; these activities will include independent third-party laboratories to ensure that an inclusive and transparent approach is adopted.

With regard to the regulatory activities and processes, the Task Force will review the process implemented by the NRA for the authorization of the discharge of ALPS treated water from FDNPS, including the approach and criteria followed by the NRA in their review of TEPCO’s REIA and Implementation Plan, and the interaction of the NRA with TEPCO. The Task Force will check the requirements placed by the NRA on TEPCO for source monitoring and environmental monitoring, and the provisions made by the NRA for an independent environmental monitoring programme. Finally, the Task Force will look at how the NRA provides information to, and engage in consultation with, parties affected by the regulatory decisions and, as appropriate, the public and other interested parties.

The IAEA’s review will extend over several years, covering the entire process until full completion, and progress will be reported in different ways. The primary means by which progress will be shared with external interested parties is through formal reports. Reports issued after review missions will reflect discussions between the Task Force and Japan as well as document observations from the Task Force. The reports will be released after each review mission. These reports, by the IAEA Task Force, will be published by the IAEA on its public website. However, these reports are intended to serve as progress reports and final conclusions will not be drawn while the IAEA’s review is still ongoing. In

2023, the IAEA will issue a comprehensive report containing the full conclusions of the Task Force across all aspects of the IAEA’s review. This comprehensive report will include the final conclusions and findings of the Task Force.

The IAEA will also establish information sharing mechanisms to distribute relevant data and updates through the IAEA’s website. This information will be shared in real-time, and near real-time, to allow interested parties to maintain awareness of the status of and developments for the ALPS treated water discharges conducted by TEPCO.

Additional information on the IAEA’s review, as well as background information, documents, reports, and other publications can be found online at the dedicated website for the IAEA’s Fukushima ALPS review.⁴

Components of the IAEA’s review

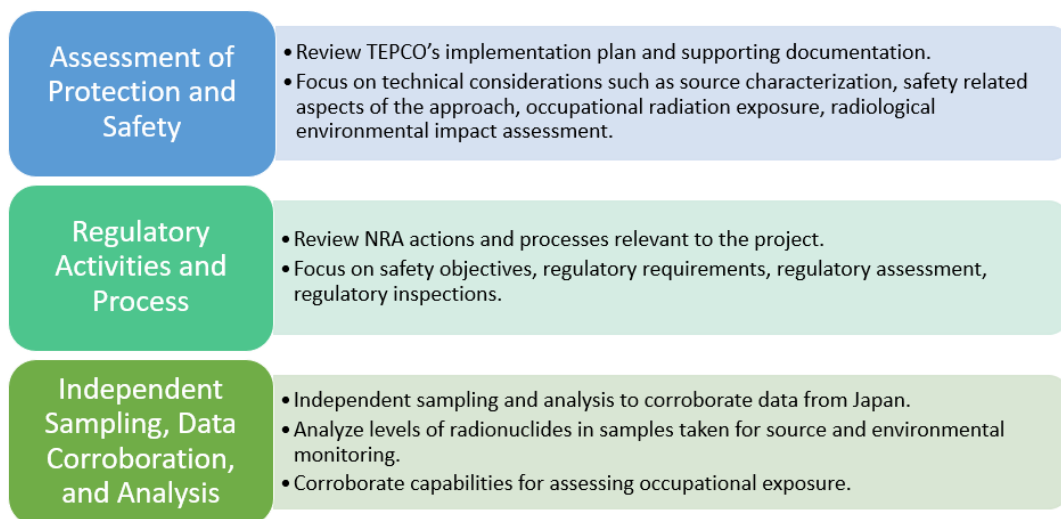


Fig. I-1. Three components of the IAEA’s review of ALPS treated water discharge.

⁴ <https://www.iaea.org/topics/response/fukushima-daiichi-nuclear-accident/fukushima-daiichi-treated-water-discharge>

I.2. Application and Description of Relevant IAEA International Safety Standards

The IAEA's Statute authorizes the Agency to "establish or adopt... standards of safety for protection of health and minimization of danger to life and property" — standards that the IAEA must use in its own operations, and which Member States can apply by means of their regulatory provisions for nuclear and radiation safety. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned. A comprehensive set of high-quality International safety standards under regular review is a key element of a stable and sustainable global safety regime, as is the IAEA's assistance in their application.

The IAEA commenced its safety standards programme in 1958. The emphasis placed on quality, fitness for purpose and continuous improvement has led to the widespread use of the IAEA standards throughout the world. The International Safety Standards Series now includes unified Fundamental Safety Principles, which represent an international consensus on what must constitute a high level of protection and safety. However, standards are only effective if they are properly applied in practice. Therefore, the IAEA is working to promote the global acceptance and use of its standards.

The IAEA's safety services encompass design, siting and engineering safety, operational safety, radiation safety, safe transport of radioactive material and safe management of radioactive waste, as well as governmental organization, regulatory matters and safety culture in organizations. These safety services assist Member States in the application of the standards and enable valuable experience and insights to be shared. Regulating safety is a national responsibility, and many States have decided to adopt the IAEA's standards for use in their national regulations. For parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions.

The IAEA Safety Standards

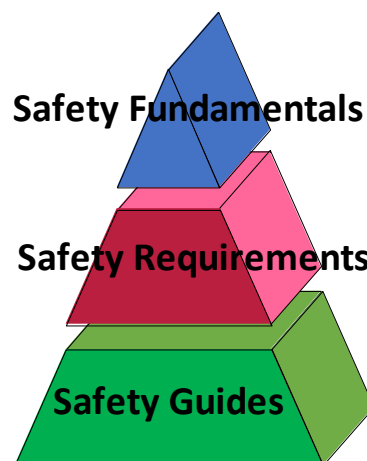


Fig. I-2. The hierarchy of the IAEA safety standards.

The IAEA International Safety Standards are also applied by regulatory bodies and operators around the world to enhance safety in nuclear power generation and in nuclear applications in medicine, industry, agriculture and research. Safety is not an end in itself but a prerequisite for the purpose of the protection of people in all States and of the environment — now and in the future. The risks associated with ionizing radiation must be assessed and controlled without unduly limiting the contribution of

nuclear energy to equitable and sustainable development. Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used beneficially, safely and ethically. The IAEA International Safety Standards are designed to facilitate this, and all Member States are encouraged to make use of them.

For the purpose of this review, the Task Force identified several IAEA International Safety Standards that are relevant for the proposed discharge of ALPS treated water into the sea. These standards address radiation protection and the safety of radiation sources, regulatory control over radioactive discharges to the environment, the structure and content of radiological environmental impact assessments, and methods for conducting environmental and source monitoring. While all IAEA International Safety Standards will be consulted as needed by the Task Force, the following are the primary safety standards referenced during this review:

- IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles: Safety Fundamentals [1];
- IAEA Safety Standards Series No. GSR Part 1, Governmental, Legal and Regulatory Framework for Safety [2];
- IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [3];
- IAEA Safety Standards Series No. GSG-7, Occupational Radiation Protection [4];
- IAEA Safety Standards Series No. GSG-9, Regulatory Control of Radioactive Discharges to the Environment [5];
- IAEA Safety Standards Series No. GSG-10, Prospective Radiological Impact Assessment for Facilities and Activities [6];
- IAEA Safety Standards Series No. RS-G-1.8, Environmental and Source Monitoring for Purposes of Radiation Protection [7].

I.3. Overview of the Mission Scope and Structure

Consistent with the request from the Government of Japan, and the mandate of the Task Force, the scope of the IAEA review is tailored to assessing safety related aspects of the implementation of Japan's *Basic Policy on Handling of ALPS Treated Water at the Tokyo Electric Power Company's Holdings' Fukushima Daiichi Nuclear Power Station*. Within the Basic Policy, the Government of Japan outlines a plan to discharge ALPS treated water into the sea. The Task Force will conduct its review on the specific approach outlined in the Basic Policy, controlled discharge into the sea, consistent with the request from the Government of Japan. The Task Force acknowledges that the domestic regulatory review of the proposed approach is still ongoing within Japan.

The IAEA conducted its second review mission to METI/TEPCO in 14-18 November 2022. The review team was comprised of experts from the IAEA Secretariat and officially designated international experts who are members of the Task Force (see Annex I). This mission forms part of the IAEA review component relating to the assessment of protection and safety and included discussions with officials and experts from TEPCO and METI.

The review team held discussions with officials of METI and TEPCO (see Annex II) at the METI headquarters in Tokyo, Japan. The review team also visited FDNPS in the Fukushima Prefecture, where the team received on-site briefings and explanations relating to the planned discharge of ALPS treated water. The review team visited key points of interest on-site, including the ALPS treatment building, the K4 tank storage yard, the site for the mixing and dilution well, the seawater intake point, and the piping pathways.

For this mission, the Task Force utilized the same structure of major technical topics (see Annex III) that was used in the first mission to METI/TEPCO (February 2022). The review against the relevant IAEA International Safety Standards was organized into 8 technical topics:

1. Crosscutting requirements and recommendations
2. Characterization of discharge/source term
3. Safety related aspects of systems and processes for controlling discharges
4. Radiological environmental impact assessment (REIA)
5. Regulatory control and authorization for discharges
6. Source and environmental monitoring programmes
7. Involvement of interested parties
8. Occupational radiation protection

The proposed discharge system and process equipment, the tanks containing ALPS treated water that will be connected to the discharge system (i.e. K4 tank group), associated operational and engineered safety controls, the safety assessment of the discharge including a prospective REIA conducted by TEPCO, radiation protection programme established and maintained by TEPCO, and other changes or enhancements to the site that are envisaged as necessary to accommodate the proposed discharge were all included within the review mission's scope. When necessary, documentation and explanations regarding the broader decommissioning effort were requested and reviewed to provide a holistic understanding for the Task Force. However, in general, the site's comprehensive decommissioning activities were considered outside the scope of this mission and the IAEA's overall safety review.

To support the IAEA review, TEPCO and the Government of Japan provided the Task Force with background reference materials and supporting data on key technical and operational considerations of the discharge system, such as data on contaminated water⁵, its generation mechanisms, and status of treatment; engineering and process information for the ALPS system; characterization of ALPS treated water and measurement methods. Additionally, throughout 2021 and 2022 TEPCO has been revising

⁵ Contaminated water is used to refer to water that has been collected by TEPCO, and not yet treated through the ALPS treatment system. This is different from ALPS treated water which has undergone chemical treatment to remove many radionuclides and must meet national regulatory standards before it can be discharged into the sea.

the Implementation Plan for FDNPS which includes the relevant data and information for the Task Force to review. Prior to this mission, the most recent Implementation Plan updates occurred in April, May, and July 2022. Based on these revisions to the Implementation Plan, the Task Force created a list of outstanding technical questions and suggestions that needed to be discussed and resolved. This was provided to METI and TEPCO prior to the mission with sufficient time to allow TEPCO to provide initial replies and plan accordingly. During the mission, TEPCO provided presentations for each of the eight technical topics listed above, with a focus on responding to specific questions and comments from the Task Force shared prior to the mission.

On the first day of the mission, METI and TEPCO provided the Task Force with a newly revised Implementation Plan (dated November 2022) that included an updated source term and a description of the selection process. While the Task Force appreciated the updated information, which addressed one of the major findings from the previous mission to TEPCO/METI, there was limited time during this mission to review the information. Therefore, while some aspects of the mission benefitted from this updated information, the Task Force noted additional time was needed to fully review and consider the changes.

The mission started with an opening session attended by high-level officials from Japan who conveyed opening remarks, and the press was also in attendance. On the first day, the review team provided an overview presentation conveying a summary of their feedback so far and existing technical questions based on the Task Force's review of reference materials prior to this mission. The mission was organized around the eight technical topics that had been previously agreed with TEPCO and METI (see list of topics above). For each technical topic, TEPCO or METI, as appropriate, provided an overview presentation that summarized the information included in the reference materials and additional clarifications on questions and issues that the Task Force had identified in advance of this mission. The review team and TEPCO/METI then engaged in an open discussion to further a shared understanding of how the actions taken by TEPCO or METI comply with national regulatory requirements and with the IAEA International Safety Standards. At the end of the week, the review team summarized the observations from the review mission in a brief presentation for TEPCO/METI and engaged in follow up discussions to ensure all participants in the mission had a shared understanding of the outcomes. The major discussion themes and observations noted by the Task Force are summarized in the 'Discussion' subsections of Part II of this report.

No further missions to TEPCO and METI are needed prior to the issuance of the IAEA's comprehensive report. Any remaining clarification or follow up will be handled through electronic communication.

I.4. Overview of the Basic Policy and the Proposed Discharge Approach

The *Basic Policy on Handling of ALPS Treated Water at the Tokyo Electric Power Company Holdings' Fukushima Daiichi Nuclear Power Station* was issued on 13 April 2021 under the authority of the Inter-Ministerial Council of Japan for Contaminated Water, Treated Water, and Decommissioning Issues. The Basic Policy contains the Government of Japan's basic premise, relevant background and an outline for pursuing discharge of ALPS treated water into the sea. In the Basic Policy the Government of Japan notes: "In order to safely and steadily proceed with decommissioning and management of contaminated water and treated water at FDNPS, based on the ALPS Subcommittee report⁶ and opinions received from parties concerned, the ALPS treated water will be discharged on the condition that full compliance with the laws and regulations is observed, and measures to minimize adverse impacts on reputation are thoroughly implemented."

The Basic Policy further notes that "...[the] discharge of ALPS treated water into the sea will be implemented at Fukushima Daiichi NPS, on the premise to make best efforts to minimize the risks by taking measures such as purification and dilution based on the ALARA principle, under strict control." In support of this decision, the Basic Policy provides background and supporting justification such as the importance of risk reduction, protecting people and the environment and ensuring that reconstruction of Fukushima can be supported. Furthermore, the Basic Policy highlights the work of the Inter-Ministerial Council in assessing other technologies for handling and managing ALPS treated water stored at the Fukushima Daiichi Nuclear Power Station.

The current approach outlined in the Basic Policy is to conduct a series of controlled discharges of ALPS treated water into the sea ('batch discharges') over a period of approximately 30 years. To implement this approach, TEPCO has proposed amendments to its Implementation Plan (i.e., its regulatory authorization to conduct decommissioning activities), including conducting a safety assessment and developing an REIA.

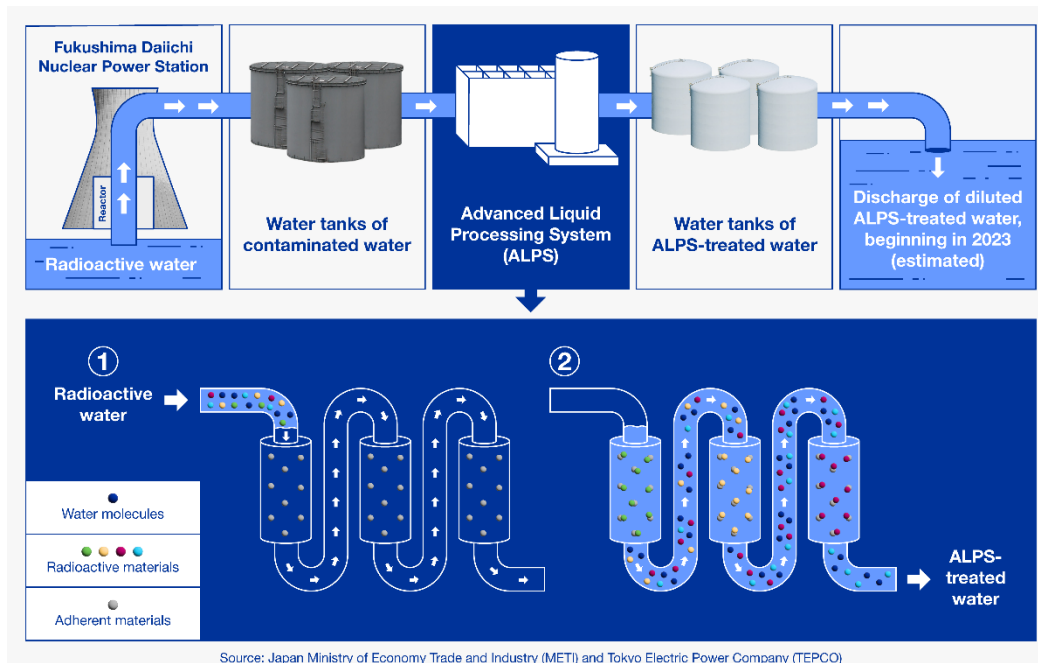


Fig. I-3. Overview of the ALPS treated water discharge system.

⁶ https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20200210_alps.pdf

TEPCO is proposing to discharge ALPS treated water, after it has been analysed and after it has been confirmed that the radionuclide inventory is in accordance with the regulatory discharge limits set in the authorization. Existing ALPS treated water varies in its radiological composition due to a variety of factors including the time when it was first generated and with what generation of ALPS treatment it was originally processed. Therefore, a secondary ALPS treatment process line will be established that will treat water currently stored on site, as necessary. This water will be processed through the ALPS facility until it meets the criteria for discharge included in the authorization. To verify this, TEPCO will organize the existing K4 tank group into three sets of 10 tanks each. Each tank set will be assigned to one of three rotating functions: receiving water from the ALPS process line, holding water that is pending analysis results and confirmation of its content, and holding water that is ready for discharge.

The water that is deemed ready for discharge will be connected to piping that transfers the water down to sea level where it will be mixed with incoming sea water. Sea water will be pumped in through the old Fukushima Daiichi Nuclear Power Station Unit 5 water intake port. The sea water and the ALPS treated water will be mixed in a mixing well in a seawater pipe header and then discharged through an undersea tunnel out to approximately 1 km from the shoreline. The discharge point identified by TEPCO is located in a zone restricted for commercial fishing. The chosen operational parameters for the discharge include an annual limit of 22 TBq of tritium, and a concentration limit of 1,500 Bq/L tritium in the discharges. Additional information on the Basic Policy and proposed discharge of ALPS treated water can be found online at TEPCO's and METI's websites [8, 9, 10].



Fig. I-4. Storage tanks of ALPS treated water at FDNPS (Source: Website of Tokyo Electric Power Company Holdings, Inc.).

II. Part II

II.1. Crosscutting Requirements and Recommendations

(a) Overview

SF-1 [1] states the fundamental safety objective and ten associated safety principles, and briefly describes their intent and purpose. The following safety principles are considered in the development of requirements applicable to discharges:

- **Principle 1, Responsibility for safety:** The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.
- **Principle 5, Optimization of protection:** Protection must be optimized to provide the highest level of safety that can reasonably be achieved.
- **Principle 6, Limitation of risks to individuals:** Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.
- **Principle 7, Protection of present and future generations:** People and the environment, present and future, must be protected against radiation risks.

These principles are applied across the entirety of the IAEA’s review and specific technical topics will arise under these principles but are addressed in more detail throughout other technical topics in this report. In addition to these cross-cutting principles, the concepts of a graded approach to addressing radiation risks, and optimization of protection across a range of technical activities are also covered in GSR Part 3 [2]. Focusing on radiation protection, GSR Part 3 [2] states that “Parties with responsibilities for protection and safety shall ensure that the principles of radiation protection are applied for all exposure situations.” Further, para. 2.12 of GSR Part 3 [2] states that “The application of the requirements for the system of protection and safety shall be commensurate with the radiation risks associated with the exposure situation.”

In the first mission to TEPCO and METI, the Task Force noted that they received the full cooperation from counterparts in Japan and received many presentations and references materials that helped to set the basis for the IAEA review. Furthermore, the first mission to TEPCO and METI helps to facilitate the understanding by the Task Force about key safety concepts such as who has the primary responsibility for safety, how the current approach proposed by TEPCO and the Government of Japan considers the protection of current and future generations and the environment, the overall authorization and regulatory approach, the application of the graded approach to this activity, and how optimization of protection was considered by TEPCO and the Government of Japan.

(b) Discussion

Discussions on specific requirements and recommendations of the IAEA International Safety Standards applicable to the review are presented in the relevant sections of this report (e.g., Section II.3 covers safety related aspects of systems and processes, Section II.8 covers occupational radiation protection). Additionally, concepts relevant to the regulatory process (e.g., dose constraints, optimization of protection, graded approach, structure of the authorization process) are addressed in greater detail in Section II.5 and are part of the missions to NRA (March 2022 and January 2023) that cover the regulatory activities and processes under the IAEA review.

During this mission, the Task Force briefly reviewed this topic and noted that no further information specific to this topic is required at this time. Given the cross-cutting nature of the safety fundamentals, it is only once all other topics have been addressed and final conclusions are drawn that the Task Force can address the safety fundamentals in a holistic manner.

(c) Summary and Follow Up

The requirements covered in this section are inherently crosscutting and represent broad concepts that pertain to multiple aspects of the IAEA review. Specifically, Topic 1 covers the fundamental safety principles applicable to the discharge of ALPS treated water. The Task Force did not request any additional information from METI and TEPCO relevant to the requirements and recommendations included in the IAEA’s International Safety Standards applicable to the review (see Appendix I).

The Task Force will continue addressing these crosscutting topics in different components of its review. The Task Force will conclude whether the fundamental safety principles have been addressed by TEPCO at the end of the full review once all other topics have been closed. This will be documented in the comprehensive report prior to the discharge of ALPS treated water.

II.2. Characterization of Discharge and Source Term

(a) Overview

In accordance with the authorization process for discharges described in GSG-9, it is recommended that the applicant seeking an authorization for the discharge of ALPS treated water, characterize the discharges. The applicant (TEPCO) is recommended to conduct a pre-operational analysis to identify the inventories of radionuclides in ALPS treated water and the amounts that will be discharged to the environment, in accordance with the graded approach. This analysis includes data on the expected inventory; and the types and activities of radionuclides that will be discharged, their physical and chemical forms, the methods and routes of discharge and the rates of discharge

At the end of the first mission, the Task Force noted that the characterization of the source term needs to be finalized and resubmitted, to allow time for review and approval by the regulatory body. The Task Force highlighted the importance of maintaining a strong connection between the characterization of the source term and the design of source and environmental monitoring programmes. TEPCO noted that based on the source characterization and REIA, they would select the radionuclides to be monitored in the sea and the wider environment.

The review of the July version of the REIA by the Task Force was used as the basis for the discussions in this mission. This version of the REIA did not include the revised source term that the Task Force had been informed was under development over the spring and summer of 2022.

(b) Discussion

The Task Force noted the importance of characterizing the source for the discharge of ALPS treated water as part of the pre-operational study in a sufficiently conservative yet realistic manner to define the source term, which is a fundamental input to the REIA, and inform robust and comprehensive plans for source monitoring.

TEPCO informed the Task Force that its methodology to characterize the ALPS treated water source term has been fundamentally revised. The underlying philosophy has been changed, from identifying the “selection of radionuclides subject to removal by ALPS” to selecting those that should be “subject to measurement and assessment with vigorous verification”. This is consistent with the requirements for characterization of discharges set out in the relevant IAEA International Safety Standards (e.g., GSG-9 para 5.20).

Characterisation of the source continues to be informed by modelling using ORIGEN (Oak Ridge Isotope Generation) software.⁷ The methodology is now also informed by the results of analyses of a broad range of radionuclides in both contaminated and treated water from various points in the processing stream over several years. A conservative “absence of evidence is not evidence of absence” approach is now utilized by TEPCO in developing the characterisation of the source term and to inform TEPCO’s plans for future source monitoring. The Task Force requested that TEPCO develop a clear, high-level description of the methodology adopted for identifying the radionuclides for inclusion in the source term, to accompany the figure that shows the steps in the REIA. TEPCO agreed to do this. The Task Force also encouraged TEPCO to consider publishing this methodology in a peer reviewed open access journal in the future with the aim of promoting transparency and encouraging confidence in the source term adopted by TEPCO and approved by the NRA. The Task Force noted that the revised source term, presented during this mission, is currently being reviewed by the NRA and could be subject to further revisions should NRA deem it necessary to meet domestic regulatory requirements. The Task Force will take into account the final, approved, source term as the IAEA’s review continues.

The Task Force noted the difference between analyses undertaken for the pre-operational study to characterize the source term and those undertaken for ongoing source monitoring. For characterization

⁷ ORIGEN is a widely used and well validated software tool for simulating ingrowth, decay, and activation in PWR and BWR reactors. This software was developed by the Oak Ridge National Laboratory in the United States.

of the source term, individual analyses of radionuclides (including actinides) are undertaken for a substantial list of radionuclides identified in TEPCO's methodology.

The Task Force understood, following discussion with TEPCO, that the methodology for selecting the radionuclides to be measured and assessed prior to discharge of each batch of ALPS treated water is comprised of 5 steps, summarised as follows.

Steps 1-3 were based on calculations performed by TEPCO:

- Step 1: The radionuclide inventories in Units 1, 2 and 3 at FDNPS 12 years after cold shutdown were evaluated. For the fuel, an initial inventory for each reactor was estimated by multiplying the uranium fraction per ton and the percentage masses of each element by a nominal mass of the core. ORIGEN was then used to assess the burnup of each fuel bundle from the time of loading until the time of the accident (including consideration of mixed-oxide fuel in Unit 3). Activation of materials comprising each reactor structure was simulated over the entire commercial operational history of each unit. Following these calculations, all radionuclides in the standard ORIGEN library (around 1000) determined to have activities less than 1 Bq per reactor core – essentially all short-lived radionuclides – were not further considered.
- Step 2: Noble gases (that cannot be present in contaminated water) were eliminated from the radionuclide inventories evaluated in step 1.
- Step 3: The maximum possible activity concentrations of all radionuclides in the contaminated stored in the tanks at FDNPS water were estimated and compared to respective regulatory limits. It was assumed that the entire radionuclide inventories of three reactors (as evaluated in step 1) were dissolved in the current total volume of contaminated water at FDNPS (1,330,000 m³). Any radionuclides for which the resulting activity concentrations were less than 1% of the respective regulatory limit were eliminated from the radionuclide inventories evaluated in step 1.

Steps 4 and 5 incorporated the results of measurement and analyses for further down-selection:

- Step 4: The potential for radionuclides to transfer from the reactors to the contaminated water was assessed and the resulting activity concentrations were compared to respective regulatory limits. Radionuclides having a similar chemical form in water were first grouped. Parent radionuclides and short-lived progeny were assumed to be in equilibrium (after the 12-year cool down period), except Zr-93 and Nb-93 (as they have not reached equilibrium as of 2022). A representative radionuclide was defined for each group (determined by contribution to dose) and a “relative ratio” was calculated for each radionuclide (the ratio of its activity as evaluated in step 1 to the respective regulatory limit, itself divided by the same ratio for the representative radionuclide). Where the relative ratio was less than 0.01, the radionuclide was eliminated from the radionuclide inventories evaluated in step 1.

A transfer coefficient was then calculated for the representative radionuclide in each group (from the periodic table): the ratio of its maximum measured activity concentration, decay corrected to the time of the accident, divided by its activity as evaluated in step 1. The activity of each radionuclide remaining following the steps above was multiplied by the transfer coefficient for the group in order to estimate its maximum estimated activity concentration. Any radionuclide having an activity concentration less than 1% of the respective regulatory limit was eliminated from the radionuclide inventories evaluated in step 1. Radionuclides not assigned to a group were assessed individually.

- Step 5: The remaining 37 radionuclides were categorised – tritium to determine the discharge flow rate and dilution factor, 30 to be measured and assessed against respective regulatory limits prior to discharge of each batch of ALPS treated water (source monitoring) and 6 that have never been detected but will nevertheless be regularly monitored⁸ (but not for each batch).

⁸ Although these radionuclides have never been detected in contaminated water, their activity concentrations in contaminated water were estimated to be less than 1% of the respective regulatory limits, and they are insoluble

The 30 radionuclides identified by this methodology and presented to the Task Force during this mission, are shown in Table II.1.

TABLE: II-1: RADIONUCLIDES IN THE REVISED SOURCE TERM PROPOSED BY TEPCO.

C-14 Carbon	Y-90 Yttrium	I-129 Iodine	Eu-154 Europium	Pu-239 Plutonium
Mn-54 Manganese	Tc-99 Technetium	Cs-134 Cesium	Eu-155 Europium	Pu-240 Plutonium
Co-60 Cobalt	Ru-106 Ruthenium	Cs-137 Cesium	U-234 Uranium	Pu-241 Plutonium
Ni-63 Nickel	Cd-113m Cadmium	Ce-144 Cerium	U-238 Uranium	Am-241 Americium
Se-79 Selenium	Sb-125 Antimony	Pm-147 Promethium	Np-237 Neptunium	Cm-243 Curium
Sr-90 Strontium	Te-125m Tellurium	Sm-151 Samarium	Pu-238 Plutonium	Cm-244 Curium

Note 1: Nuclides with a red border were added to ensure the approach is conservative.

Note 2: Tritium will also be measured in addition to these radionuclides.

Additionally, beyond the 30 radionuclides included in Table II-1, TEPCO has identified six additional radionuclides that, while not detected in significant quantities in past analyses, will be monitored routinely to ensure a conservative approach is adopted. These additional radionuclides are Cl-36, Fe-55, Nb-93m, Nb-94, Mo-93, Ba-133.

The TF noted that the efficiency of ALPS and the other systems designed to reduce activity concentrations of radionuclides in contaminated water at FDNPS is not considered directly at any point in the above process even though, undoubtedly, the activity concentrations of radionuclides targeted for removal by ALPS would be expected to be lower following treatment.

The TF also noted that the potential presence of progenies in the source term, even those with very short half-lives, was assessed by TEPCO using the methodology described above. Most were eliminated at step 4 but Y-90 (2.6 d half-life, progeny of Sr-90) and Te-125m (57 d half-life, progeny of Sb-125) were not and have been included by TEPCO in its source monitoring plan and in the REIA. According to this plan, levels of both radionuclides will be assessed through measurement of their respective parents and assuming equilibrium.

The Task Force noted that the screening analytical methods (i.e., gross alpha and gross beta) that TEPCO has used as part of characterising the source term, are generally used to indicate whether further

and therefore considered removable in general, their inventory activities (determined in step 1) are also relatively large and they have long half-lives. Therefore, to take stock of possible changes as decommissioning at FDNPS progresses, it was decided to regularly monitor levels of these radionuclides in ALPS treated water,

radionuclide specific analyses are required. This approach is sufficiently conservative. The Task Force asked TEPCO to confirm that the use of screening methods is effective for the full range of relevant radionuclides being characterised in the source term.

Following discussions with TEPCO, the Task Force understood that radionuclide specific analyses of alpha and beta emitting radionuclides have also been undertaken as part of the pre-operational study. Gross alpha screening (not beta) will only be used for source monitoring, which will be undertaken on an ongoing basis to ensure that discharges comply with authorised limits. The Task Force agreed that the gross alpha screening method used is sufficiently conservative for this purpose. TEPCO stated that beta screening will be used only as an extra check for any potential additional beta emitting radionuclides that may be present in ALPS treated water. The Task Force understood TEPCO's explanation that even if these radionuclides were present, their activity would be expected to be extremely low.

(c) Summary and Follow Up

Based on the information presented by TEPCO during this mission and extensive discussion, the Task Force had an overall view that the revised methodology for characterizing the source term is sufficiently conservative yet realistic. TEPCO agreed to include a simplified summary of the most significant steps in the process for selecting radionuclides to be included in the source term. The Task Force identified that they may have further questions and comments on the detailed methodology used by TEPCO following a more detailed review of the November 2022 version of the REIA. The Task Force reiterated that TEPCO should repeat the calculation of doses to the public and the environment in the REIA using the more realistic representative source term now that this was available. The revised source term presented to the Task Force during this mission is currently being reviewed by the NRA and could be subject to further revisions should NRA deem it necessary to meet domestic regulatory requirements. The Task Force will take into account the final, approved, source term as the IAEA's review continues.

After the conclusion of the mission and based on a more robust review of the November 2022 version of the REIA, the Task Force identified that this simplified summary of key steps is still outstanding and may raise additional technical questions to TEPCO about the characterization of the source term. The Task Force will continue to work with TEPCO to resolve any further questions that will help to fully clarify the existing situation and thus allow the Task Force to draw its final conclusions as part of the comprehensive report. In February 2023 TEPCO further updated the Implementation Plan to include a revised REIA, with the intent of addressing comments from the Task Force.

II.3. Safety Related Aspects of Systems and Processes for Controlling Discharges

(a) Overview

In accordance with the requirements established in GSR Part 3 [2], the licensee is required to conduct an appropriate safety assessment for the discharge of ALPS treated water from the Fukushima Daiichi nuclear power station and submit it for subsequent review and assessment by the regulatory body prior to authorization. The safety assessment aims to identify the ways in which exposures could be incurred, to determine the expected likelihood and magnitudes of exposures in normal operation and to assess the adequacy of the provisions for protection and safety. The safety assessment is required to include a review of the operational limits and conditions for the operation of the discharge; the ways in which structures, systems and components relating to protection and safety might fail, and the consequences of such events; the ways in which external factors could affect protection and safety; the ways in which operating procedures relating to protection and safety might be erroneous, and the consequences of such errors.

At the end of the first mission the Task Force highlighted the significant amount, and level of detail, of analyses performed by TEPCO for the conduct of the safety assessment, its comprehensive approach, as well as the fact that a large number of potential single failure events were taken into consideration for the development of the design criteria for the discharge of ALPS treated water. The Task Force noted that TEPCO would be expected to ensure that all aspects considered for the safety assessment, including the methodology and the data used, be sufficiently documented in the safety assessment. In addition, the Task Force mentioned the importance of making a comprehensive assessment considering all failure modes and identifying the different initiators that might lead to the discharge of undiluted ALPS treated water; the work done to highlight this should be properly documented in the implementation plan.

Subsequently, after the first mission to TEPCO and METI, TEPCO updated the Implementation Plan in April, May, and July 2022 and the Task Force utilized these updates to consider any relevant changes that impacted its assessment of safety related aspects of systems and processes for controlling the planned discharges.

(b) Discussion

During the mission, the Task Force briefly presented on its continued review of this topical area. In particular, the Task Force noted that the updates to the implementation plan throughout 2022 were useful in better understanding the system design for the various components related to the planned ALPS treated water discharges. In particular, the Task Force noted the large effort put forward by TEPCO in designing robust engineering controls, and in considering redundant safety features to protect against unexpected, or low probability, occurrences. Furthermore, the Task Force understands that an appropriate analysis of possible accident scenarios and the consequences thereof was conducted and included as part of the revised implementation plan submitted to the NRA for approval.

The Task Force had no remaining questions for TEPCO regarding this technical topic, and TEPCO did not request clarification on any statements or follow up by the Task Force.

(c) Summary and Follow Up

Based on the Task Force's review of the updated implementation plan, including key portions of the REIA, the Task Force has noted that the issues identified in the first ALPS report [11] have been addressed in an appropriate manner.

The Task Force noted that no further questions or concerns remained, but that it would continue studying the November 2022 and subsequent updates to the implementation plan to ensure no further issues arise.

Additionally, the Task Force noted that they will observe key pre-service inspections conducted by NRA to demonstrate that the engineering systems and processes are fit for service and will fulfil their safety-related purpose.

II.4. Radiological Environmental Impact Assessment

(a) Overview

The regulatory control and authorization of discharges is covered in Section 5 of this report, where it is further explained that the establishment of an authorization for discharges should take into account the results of a prospective assessment of the radiological environmental impacts; such an assessment is usually called a Radiological Environmental Impact Assessment (REIA).

The responsibilities placed on the registrants or licensees when applying for an authorization to discharge to the environment are given in GSR Part 3. Paragraph 3.9 of GSR Part 3 states that:

“Any person or organization applying for authorization:

(e) Shall, as required by the regulatory body, have an appropriate prospective assessment made for radiological environmental impacts, commensurate with the radiation risks associated with the facility or activity”.

At the end of the first mission, the Task Force and TEPCO agreed that, in the REIA, a more detailed and thorough written description of the modelling, assumptions, and data is needed to reflect the work that TEPCO has done and to provide confidence in the results of the REIA. Several key assumptions in the REIA regarding the behaviour of radionuclides in the environment and the calculation of prospective estimates of the dose to members of the public were discussed. The Task Force and TEPCO agreed that further evaluation is needed to provide evidence that the assumptions made are appropriate and sufficiently conservative. TEPCO agreed to consider the feedback from the Task Force when preparing a revised REIA.

In July 2022, TEPCO published a revised REIA that addressed the comments made by the Task Force but had not yet incorporated a revision to the source term which was being further developed following the first mission (see Section II.2). A review of the July version of the REIA by the Task Force was used as the basis for the discussions in this mission. However, at the beginning of this mission, TEPCO provided another revised version of the Implementation Plan that was just submitted to the NRA, which also included a revised REIA taking into account a new source term. This version had not been seen by the Task Force prior to this mission but was referenced throughout the mission when possible, noting the limited time available to the Task Force to review it.

(b) Discussion

During the mission, TEPCO provided an overview of the updates made to the methodology in the revised REIA, both in the July 2022 version to address the comments from the Task Force from the first mission and the November 2022 version, which contained the revised source term and updated dose assessment.

Source term used for the REIA

The Task Force had previously noted that once the revised source term is available, TEPCO should assess whether the related assumptions in the REIA (i.e., assumptions that are dependent on the source term) remain valid. TEPCO indicated that they indeed considered this feedback and confirmed that the revised source term did not impact the assumptions made in the REIA. However, the TF noted that as a consequence of revising the source term, the radionuclides now contributing most to the dose have changed. In particular, C-14 and I-129 are now in the top three radionuclides contributing most to the overall dose to the representative person from the discharge of the APLS treated water. While the overall estimated dose from the source term remains extremely low, TEPCO agreed to include further information on the radiological impact of the planned discharge of C-14 and I-129 and a specific discussion on the approach adopted for the behaviour of C-14 and I-129 in the environment in the REIA, given the contribution of these radionuclides to overall doses.

Behaviour of radionuclides in the environment and estimation of activity concentrations in food and the environment

The Task Force noted that TEPCO had provided an explanation for how it treated bioaccumulation in sediments over the total discharge period and stated that the doses from ingestion of seafood are conservative. TEPCO provided further explanation that, prior to the accident at FDNPS in 2011, when routine discharges were broadly comparable to those expected from ALPS, activity concentrations of radionuclides in sediments were in a transient state approaching a dynamic equilibrium. The Task Force understands that this can be expected considering constant releases into the ocean and given the specific radionuclides being discharged.

Following further discussion, the Task Force understood and accepted the approach taken for bioaccumulation by TEPCO in the July 2022 version of REIA. For dose pathways relating to seawater, TEPCO explained that it has been assumed that the concentration in seawater is not depleted by transfer to the sediments, and it stays at this level throughout the discharge period. For dose pathways relating to sediments, TEPCO has conservatively assumed that there is dynamic equilibrium between seawater and sediments from the first year that discharges occur even though equilibrium would not actually be expected to occur for a number of years after discharges start. In summary, TEPCO has calculated the highest committed effective dose that would occur over the 30-year period assuming that discharges will be consistent and continuous. This is equivalent to “dose commitment” which was addressed in page 31 of the first ALPS report [11].

The Task Force noted that TEPCO has not considered in-growth of progenies in the sediments over the discharge period. Whilst this is not expected to change the overall doses, the Task Force suggested that their reasoning for not including this could be described more clearly in the REIA.

The Task Force further noted that it is not clear as to whether sedimentation is included in the dose assessments for humans and flora and fauna based on the modelling approach that has been used (described in Attachment 6 of the July 2022 revision of the REIA). TEPCO confirmed that the methodology described had only been used to identify minor exposure pathways and had not been used in calculations of doses. TEPCO agreed to make this clear to avoid confusion.

The Task Force noted that TEPCO has now taken account of a fraction of OBT in the environment based on ICRP 56. However, ICRP 56 says that the exact proportions of OBT in the various molecular components of the human diet are unknown and there are uncertainties associated with the doses received following the intake of tritium. It was agreed that there are uncertainties about OBT formation in seafood and the associated doses to humans, flora and fauna. However, the Task Force and TEPCO acknowledged that assuming tritium is 100 % OBT would not change the overall dose significantly because tritium is a minor contributor to dose (less than 1%). The Task Force noted that this is likely to be a topic of interest to many interested parties and suggested that TEPCO explain the uncertainties in OBT formation and the associated doses further.

The Task Force noted that the calculational area of simulations for the marine dispersion model is 490 km north-south and 270 km east-west and had encouraged TEPCO to use longer distance dispersion calculations to show clearly that doses to neighbouring countries are negligible. TEPCO explained that based on meteorological and oceanographic conditions over a 7-year period from 2014 to 2020, the marine dispersion model predicts very low concentrations of tritium that will be undetectable at the boundary of the simulation area (490 km north-south and 270 km east-west of the FDNPS). The Task Force accepted TEPCO’s reasoning that concentrations of tritium beyond this area will be even lower and therefore there is no scientific justification for redoing the calculations for a larger area. The Task Force noted that including estimates of activity concentrations of C-14 and I-129 in seawater at the boundary of the simulation area could also demonstrate that the concentrations of these radionuclides are negligible.

Identification of the representative person

In the REIA, TEPCO has stated that whilst there are currently no permanent inhabitants 3 km north of the site, the representative person could still travel to the beach in that area. Therefore, TEPCO has used this location for calculation of external doses. TEPCO acknowledged that individuals could also catch fish and collect seafood from this location at some point in the future. However, TEPCO stated it would only be a small proportion of their fish or seafood consumption and would not contribute

significantly to the overall dose. TEPCO further acknowledged that not including consumption of seafood from this location by the representative person may be questioned. The Task Force requested that TEPCO provides further explanation as to why the consumption of some or all seafood caught at the location 3km north from the site on the coast is not taken into account, particularly as when calculating potential exposures, the representative person is assumed to consume seafood at this location.

Assessment of doses from potential exposures

The Task Force noted that it was not clear which age group has been assumed for the representative person in the calculations for the assessment of potential exposures and this needs to be better explained. Justification is also needed for why only a single age group has been considered. TEPCO stated that the representative person for the potential exposure assessment is a fisherman (adult) who consumes seafood from 3km north of the site. TEPCO further explained that they had now included doses from internal exposure pathways for other age groups (inhalation of sea spray, ingestion of seafood and inadvertent ingestion of water) and had updated the assessment to include external exposures to all age groups in the revised REIA (November 2022). The Task Force requested TEPCO to clearly explain and justify the exposure pathways included for the different age groups in the assessment of potential exposures.

For potential exposures, GSG-10 states that the effective dose should be calculated for doses in the range of stochastic effects. It also states that the equivalent dose to certain organs (e.g., thyroid) can be considered; the Task Force suggested that TEPCO addresses this. TEPCO explained that, although a higher concentration of radionuclides would be released in the event of an accident, the radionuclides are the same and the behaviour in the environment and exposure pathways are the same. TEPCO stated that the predicted effective doses are very low, including the dose from I-129 (approx. 0.01 mSv) that the assessment of equivalent dose (e.g., to the thyroid for infants) is not needed at these very low levels of effective dose. The Task Force agreed with this technical evaluation.

Consideration of uncertainties

As an outcome of the first mission to TEPCO and METI and as a result of their review of the July 2022 revision of the REIA the Task Force noted that they would like to further discuss with TEPCO the use of sensitivity analysis to quantify the impact that selected assumptions and parameter values have on the doses calculated, namely the assumed fraction of tritium that is OBT in the environment and bioaccumulation of radionuclides in the environment over the proposed duration of discharge of ALPS treated water. These topics were discussed with TEPCO and residual actions for these topics are given in (c).

(c) Summary and Follow Up

The Task Force had reviewed in detail the July 2022 revision of the REIA and discussed its outstanding comments and observations during the mission. TEPCO had addressed these comments prior to the mission and subsequently made updates to the REIA (November 2022 version) which were presented to the Task Force during the mission. A number of further suggestions were made by the Task Force to provide further justification or explanation of the assumptions and methodology that has been used in the REIA, as described above. In particular, the Task Force suggested that TEPCO include:

- a clearer explanation of the dose calculation to the representative person over the proposed period of discharge, such as explaining that for dose pathways relating to sediments, the dose predicted for the first year (assuming equilibrium between seawater and sediments) is equivalent to the highest dose in the 30-year period;
- a better justification for excluding the contribution to the ingestion dose from consuming fish caught at the shoreline at 3km, noting that concentrations in seafood are likely to be higher at this location than in the area used for commercial fishing;
- a clearer explanation of the uncertainty in OBT formation and the associated doses, and consider performing the calculation assuming 100% OBT to definitively show that this

assumption does not have a meaningful impact on the final estimated dose to the representative person;

- estimates of C-14 and I-129 concentrations in sea water at the boundary of the simulation area and other radionuclides that contribute significantly to the dose.

In general, the remaining technical points highlighted above will not prevent the IAEA from drawing conclusions regarding whether TEPCO is adhering to the relevant IAEA International Safety Standards. Rather, significant discussion between the Task Force and TEPCO was needed during missions and other technical discussions in order for the Task Force to fully understand the approach and assumptions made by TEPCO in the assessment of doses to the public and the environment. The Task Force strongly believes the points listed above should be clearly documented so that interested parties can more easily understand the assumptions and calculations made as part of the REIA.

Following this mission, TEPCO further updated the REIA in February 2023 and addressed the remaining comments from the Task Force on the REIA except for outstanding comments from the Task Force on the source term (see Chapter II.2). The impact of any further changes to the source term on the estimation of doses to the public and the environment remain to be assessed by TEPCO and reviewed by the Task Force. TEPCO has committed to provide this information to the IAEA in a timely manner.

II.5. Regulatory Control and Authorization of Discharges

(a) Overview

For facilities or activities that might present potentially higher radiation risks, it may be appropriate for the regulation of the releases from such facilities or activities to be managed by means of an authorization (registration or licensing, as relevant). This authorization establishes stringent technical and regulatory conditions, including for the adequate management and control of these discharges and their radiological consequences. In accordance with the requirements established in GSR Part 3, discharges are required to be properly managed by the licensee in order to ensure the optimized protection of the public and the environment.

At the end of the first mission, the Task Force noted that while a significant amount of work and analysis appeared to have been conducted in support of the proposed ALPS treated water discharge, this effort needed to be clearly explained and documented in the context of the IAEA International Safety Standards to help demonstrate compliance with relevant requirements. The Task Force noted that further discussions would be needed to clearly define how the approach to establishing dose constraints and discharge limits complies with the requirements and recommendations outlined in the relevant IAEA International Safety Standards.

The Task Force referred to its review of the July version of the REIA as the basis for the discussions in this mission.

(b) Discussion

TEPCO provided an overview of the updates made in the revised REIA, both in the July 2022 version to address the comments from the Task Force from the first mission to TEPCO and METI; and the November 2022 version, which contained further information of relevance to this chapter.

Following the Task Force review of the July 2022 version of the REIA, the Task Force encouraged TEPCO to calculate the upper limit of annual discharges for key radionuclides (i.e., radionuclides that have the highest radiological importance based on REIA results that would result in doses equivalent to the dose constraint of 50 μSv per year).

TEPCO presented the upper limit of annual discharges for the 31 radionuclides⁹ in the revised source term (i.e., annual discharges that would result in doses equal to the dose constraint). These were presented for three different source terms (K4, J1-C and J1-D) to account for variations in the source term. TEPCO acknowledged that dose constraints (and the associated upper limit of annual discharges for radionuclides that contribute to overall dose) serve as the boundary for optimization.

The Task Force explained that GSR Part 3 includes requirements pertaining to optimisation of protection. GSG-9 reiterates the need for optimisation of protection and Figure 3 in GSG-9 indicates the role of the applicant to consider optimization of protection to inform the setting of discharge limits by the regulatory body. The Task Force noted that there was no explicit evidence of optimization in the July 2022 version of the revised REIA.

The Task Force and TEPCO discussed the principle of optimization as presented in SF-1, GSR Part 3 and GSG-9 Annex 1. The Task Force confirmed it is interested only in optimization of protection associated with discharges of ALPS treated water, with the decision by the Government of Japan to discharge ALPS treated water being out of scope of the IAEA review. The Task Force noted that doses predicted in the REIA are below 10 μSv (i.e., at a level below which optimization should not normally be required). However, the Task Force emphasized that optimization is not the same as dose minimization and actions to reduce doses must do more good than harm, accounting for economic,

⁹ The revised source term presented to the Task Force during this mission is currently being reviewed by the NRA and could be subject to further revisions should NRA deem it necessary to meet domestic regulatory requirements. The Task Force will take into account the final, approved, source term as the IAEA's review continues.

societal and environmental factors. The Task Force again acknowledged that the Japan government policy has already defined discharge limits. However, it noted that it is helpful to show interested parties that a higher discharge rate would still meet the dose constraint and that the discharge limit defined in government policy is conservative to take account of societal concern. The Task Force emphasized that TEPCO should explain the impact of reducing doses (to public and environment) on other factors valued by interested parties (economic, societal and environmental factors). TEPCO should also make it clear why the proposed approach does more good than harm at this point in time. The Task Force noted that this clarity could help TEPCO when engaging with interested parties in the future and communicating about any potential changes with the discharge approach.

(c) Summary and Follow Up

The Task Force had reviewed in detail the July 2022 version of the REIA and discussed the outstanding comments and observations during the mission. TEPCO had addressed these comments prior to this mission and made updates to the REIA (November 2022 version) which were presented to the Task Force during the mission. A number of further comments were made by the Task Force.

In line with SF-1, GSR Part 3 and GSG-9, the Task Force requested TEPCO to draft a chapter in the REIA describing the optimization of protection in a qualitative manner for the discharge of ALPS treated water. The chapter would ideally include a written explanation of annual discharges that meet the dose constraint; options for reducing dose below the dose constraint; and impacts on other factors from reducing doses (to public and environment). The Task Force notes the overriding importance placed on current societal concerns in the Basic Policy for the discharge of ALPS treated water. The Task Force also suggested that TEPCO include upper limits of annual discharges (corresponding to the dose constraint) in their qualitative description of the optimization process.

Following this mission, another revision to the REIA was submitted to NRA in February 2023 that included the more detailed explanation of the optimization process. The Task Force is currently reviewing this revised REIA and will include final conclusions in the comprehensive report.

II.6. Source and Environmental Monitoring Programmes

(a) Overview

Requirement 14 of GSR Part 3 on monitoring for verification of compliance states that “Registrants and licensees and employers shall conduct monitoring to verify compliance with the requirements for protection and safety.”

With regard to environmental monitoring, GSG-9 provides recommendations on conducting a pre-operational analysis (before the discharges start) to determine the existing levels of background radiation in the environment surrounding the facility prior to the first discharge and to establish a baseline. In accordance with RS-G-1.8, more frequent and detailed environmental measurements may be needed in the early stages of operation and all monitoring programmes are recommended to be subject to periodic review to ensure that measurements continue to be relevant for their purposes.

During the first mission, the Task Force noted that there was a need for a clearly defined and definitive plan for source monitoring covering sampling and analysis at the measurement and confirmation facility; the vertical discharge shaft; and any other relevant locations. While welcoming the plans for enhanced environmental monitoring by TEPCO and the GOJ, the Task Force requested further clarification as to the role of TEPCO as FDNPS operator within the GOJ plan for environmental monitoring and also stressed the importance of linking the environmental monitoring programme to the results of the REIA.

(b) Discussion

Monitoring at the source of the discharge

The Task Force discussed with TEPCO the results of its circulation and agitation test designed to demonstrate the methodology for achieving homogeneity in the K4-B tank group (and hence in all future measurement and confirmation facilities). This test involved adding a stable tracer to the water in the K4-B tank group (comprised of 10 interconnected tanks). Water was circulated between the tanks using pumps and the contents of each were agitated. The concentrations of this tracer were measured in water samples collected at multiple points in each tank at regular intervals over a 6-day period. At the end of this time, activity concentrations of radionuclides were also measured in samples collected at multiple points in each tank. The Task Force was content that homogeneity was demonstrated by this test and that the extent of sampling undertaken was adequate. The Task Force noted that achieving homogeneity in each batch of ALPS treated water prior to sampling for source monitoring purposes was vitally important. The Task Force queried how TEPCO intended to demonstrate that the equipment used could be relied upon to remain effective over the entire period of the discharges. TEPCO agreed with the Task Force on this point and noted that it would be addressed in the general maintenance plan for the measurement and confirmation facilities that is currently being developed. TEPCO agreed that the maintenance plan could be shared with the Task Force prior to the start of discharges.

Monitoring in the Environment

During the mission, the Task Force noted that TEPCO needed to more clearly explain how radionuclides contributing most to the dose to the representative person are included in the environmental monitoring programmes and are linked to the REIA, as required in the IAEA International Safety Standards. TEPCO explained that most radionuclides will not be detectable in the seawater, sediment, fish and seafoods even though they are included in the sea area monitoring. Environmental monitoring specific to the ALPS treated water discharge is therefore focused on Cs-137, tritium (OBT and tritiated water) and I-129. Within the context of the CRMP, this monitoring is performed in parallel with ongoing monitoring of other radionuclides (e.g., Sr-90 and Pu isotopes in seawater and sediment). TEPCO agreed to include a more detailed description of the monitoring and how it is linked to the important exposure pathways and radionuclides contributing to the doses to the public and environment in the revised REIA.

During the mission, the Task Force explained that it was not clear in the REIA whether TEPCO has now included sampling points in their enhanced environmental monitoring plan to measure activity

concentrations in the environment at the location of the representative person (i.e., the new assessment point along the coastline 3km north of FDNPS). The Task Force noted that this needs to be clearly described in the REIA. TEPCO stated that they have not included a sampling point at 3 km north of the site because the predictions of the external exposures for use of the beach at this location have reduced by 1 to 2 orders of magnitude and are very low. TEPCO is monitoring seawater near the discharge outlet at the north end of the site and 6 km north of the site. The Task Force accepted the reasoning provided by TEPCO and suggested that TEPCO clearly document this explanation in the REIA.

The Task Force explained that they are aware that baseline environmental monitoring is being undertaken under the CRMP. The Task Force reiterated the importance of baseline monitoring to help verify the impact of discharges on environmental concentrations and doses in the REIA report; this is one of the roles of environmental monitoring described in the IAEA International Safety Standards. From the presentations made by TEPCO and the information made available to the Task Force, the Task Force agreed, based on this information, that the baseline monitoring programme is comprehensive. However, the information provided in the REIA does not clearly explain how TEPCO will compare the results of future environmental monitoring against the baseline data that has recently been collected to assess any measurable impacts from the discharges of ALPS treated water. The Task Force requested written clarification on this point in the REIA or another document published by TEPCO.

(c) Summary and Follow Up

From the presentations made by TEPCO, the information made available to the Task Force during the mission, and section 9-3 of the REIA, the Task Force understands TEPCO's environmental monitoring programmes and agrees that it is comprehensive. However, a few remaining issues (see below) need to be addressed before final conclusions can be drawn by the Task Force.

- The Task Force requested TEPCO to describe how the results of environmental monitoring after the discharges start will be compared against the baseline and how this comparison will be used to assess any measurable impacts from the discharges of ALPS treated water.
- The Task Force requested TEPCO to explain what actions would be taken if the measurements indicate the dose to the representative person is different to the dose predicted in the REIA.

During the meeting, the Task Force accepted the explanation and justification of the radionuclides to be monitored by TEPCO and included in the CRMP, which focuses on the area around the discharge point.

Following this mission, TEPCO submitted a revised Implementation Plan in February 2023 that included a revised REIA. This new revision of the REIA addressed the remaining comments from the Task Force on environmental monitoring that were raised in this mission. The Task Force will continue to review the maintenance plan for the measurement and confirmation facilities that is currently being developed by TEPCO.

II.7. Involvement of Interested Parties

(a) Overview

In the IAEA International Safety Standards, the term interested parties is used in a broad sense to mean a person or group having an interest in the activities and performance of an organization. In the context of radioactive discharges to the environment, ‘interested parties’ typically include individuals or organizations representing members of the public; industry; government agencies or departments whose responsibilities cover public health, nuclear energy and the environment; scientific bodies; the news media; environmental groups; and groups in the population with particular habits that might be affected significantly by the discharges, such as local producers and indigenous peoples living in the vicinity of the facility or activity under consideration.

IAEA International Safety standards include requirements and recommendations on involving interested parties and allowing for an exchange of information between the regulatory body, the applicant, and interested parties. Furthermore, the IAEA International Safety Standards note that some interested parties may be located in other States, especially in neighbouring States. Any exchange of information relating to the control of discharges may form part of other decision-making processes. Such exchange of information should include consideration of societal aspects, for example public concern over the risks associated with radiation exposure, and consideration of the doses to the public that might result from discharges during operation.

At the end of the first mission to METI and TEPCO in February 2022, the Task Force commended TEPCO on the approach they follow for the engagement of different groups of interested parties. Additionally, the Task Force acknowledged the significant efforts made by METI and TEPCO that demonstrate their commitment to transparent communication by making publicly available much of the information and data associated with the proposed discharge of ALPS treated water. The Task Force further noted that they are interested in continuing to receive information on the approach followed by TEPCO, METI, and the broader Government of Japan regarding the involvement of interested parties throughout the duration of the IAEA’s review.

(b) Discussion

During the mission METI provided a presentation to update the Task Force on major outreach activities since the previous mission in February 2022. This presentation provided information on the involvement of interested parties that live in the area around the Fukushima Daiichi Nuclear Power Station, local government officials and groups, and school-age students. Additionally, METI updated the Task Force on the means through which it is intending to engage with interested parties, such as through major internet websites and media. Finally, METI compiled information regarding what the Government of Japan and TEPCO have been doing to engage with the international community, specifically focusing on outreach to countries who have expressed interest in discussing directly with the Government of Japan.

METI also shared an English translation of the “Action Plan for the Continuous Implementation of the Basic Policy on Handling of ALPS Treated Water” with the Task Force. This document is an earlier version of the Action Plan but METI discussed the content, noting the different main components and how it helps to guide the Japanese Government and TEPCO in their outreach to different groups of interested parties. METI also confirmed that the Action Plan is a long-term approach that considers current activities as well as future activities in the next year, and the mid to long term timeframe, satisfying the Task Force’s previous comments on this subject.

The Task Force had no remaining questions for TEPCO. However, METI noted that a new (August 2022) version of the Action Plan was available and was working to translate this into English. METI subsequently provided this translated Action Plan in January 2023.

(c) Summary and Follow Up

At the end of the mission the Task Force acknowledged the significant outreach activities and efforts take by TEPCO and METI to ensure transparency. For future consideration (i.e., after the discharges of ALPS treated water begin), the Task Force noted that relevant industry counterparts could be considered as interested parties to provide access to best practices and experiences. Additionally, habit data should be updated over time using the involvement of local interested parties as a key means of acquiring these data. This practice would help to ensure habit data continues to reflect “real practices” in the inhabited areas around the Fukushima Daiichi Nuclear Power Station.

II.8. Occupational Radiation Protection

(a) Overview

GSR Part 3 sets requirements for establishing and maintaining organizational, procedural, and technical arrangements for the designation of controlled areas and supervised areas, for local rules and for monitoring of individuals and the workplace, under the radiation protection programme for occupational exposure. In most practices, doses received by occupationally exposed workers are expected to be below the relevant dose limits indicated in GSR Part 3, and only a small fraction of the workforce will potentially be affected by the requirements for dose limitations. In these cases, the continuation of individual monitoring needs to be reviewed, along with whether workplace monitoring is sufficient for radiation protection purposes and for compliance with the national requirements. The requirements for optimization should be the principal impetus for the establishment and implementation of a radiation protection programme, including, in many cases, measures to prevent or reduce potential exposures and measures to mitigate the consequences of incidents and accidents. In accordance with paragraph 3.49 of GSG-7, the general objective of a radiation protection programme for occupational exposure is to fulfil the management's responsibility for protection and safety through the adoption of management structures, policies, procedures, and organizational arrangements that are commensurate with the nature and extent of the risks.

At the end of the first mission, the Task Force asked TEPCO to clearly describe the procedure they follow for optimization of protection and safety of ALPS equipment and facilities. The Task Force also requested a comprehensive explanation of how TEPCO is meeting dose limits and optimizing doses to workers and further information for arrangements of work permits and training of staff who will be responsible for the operation of ALPS facilities and equipment.

(b) Discussion

During the mission, TEPCO provided a detailed explanation of the arrangements under its Radiation Protection Programme for the ALPS facilities and equipment. Operation of the ALPS facilities and equipment will not require a dedicated group of work crews and the same radiological controls apply to the contractors as well as TEPCO workers. TEPCO informed the Task Force that requirements for radiation control are listed in the "Radiation Control Specifications" and are included in the contractual agreements for contractors. The protection policy specified in the "Radiation Control Specifications" and the protection policy of "Radiation Control Basic Manual" set by TEPCO have the same methodological approaches whereby the primary responsibility for protection and safety stays with TEPCO.

The "Radiation Control Plan" and "ALARA Check Sheet" (copies of these documents were provided to the Task Force during the mission) are formulated for proper implementation of control measures for engineering in design, installation, maintenance, and operation, together with administrative arrangements including work management and work permits. The Radiation Control Plan includes all necessary work authorization details (e.g., area category, working period, planned working hours, planned working dose, etc.), radiation protection measures (e.g., use of PPEs, such as β - protective glove, full face mask, etc.), and estimated and actual doses with necessary dosimetric details. Potential exposure scenarios are also considered (e.g., pipe rupture, tanks damage, etc.) for their radiological hazards and control measures. The ALARA Check Sheet is a practical tool for supervision and used by workers to quickly check control measures. The ambient dose equivalent rate is measured in fixed locations nearby the ALPS equipment and facilities. The examination of engineering countermeasures, management/ administrative measures, and use of PPE is based on the ambient dose equivalent rate (mSv/h), the workplace surface contamination density (Bq/cm²), and airborne radioactive material concentration (Bq/cm³).

Regarding ³H, TEPCO informed the Task Force that a decision to measure the ³H concentration in the air is based on the tritium concentration in ALPS treated water; if the concentration exceeds the control standard $2 \times 10^{-1} \text{Bq/cm}^3$, measures are taken such as providing ventilation at the workplaces and restricted working hours. However, during the mission TEPCO provided records demonstrating that the evaluation value has never exceeded the control level since the beginning of operation.

With regard to monitoring and dose assessment, the Task Force was informed that all workers entering the management area (the entire site is considered a controlled area) of FDNPS are required to use PPE and personal passive /active dosimeters regardless of the magnitude of the exposure. Additionally, all workers are monitored periodically by in-vivo radiobioassay for internal exposure due to ^{137}Cs using whole body counter with plastic scintillation detectors. ^{90}Sr nasal cavity sampling and monitoring is conducted at FDNPS, and a software called “Monitoring to Dose Calculation” (MONDAL) is used for internal dose assessment, as confirmed during the first mission to METI and TEPCO and verified during this mission. The Task Force noted that radiological data from the first-generation ALPS (operational since 2013) system is a reliable source for further planning.

TEPCO informed the Task Force that dose limits for occupationally exposed workers are set in national legislation. The upper dose limits used by TEPCO is 20 mSv/y and the operational criterion regarding occupational radiation protection at FDNPS set by the Plant Chief Superintendent is 18 mSv/y (which is interpreted as a dose constraint by TEPCO) and applies to all activities on site, including the operation of the ALPS facilities and equipment. As discussed earlier, the Radiation Control Plan includes control mechanisms for each work category and includes the planned dose per day for each operation. In a day is exceeded, a working situation confirmation is conducted, and a work management review is required. In principle, the daily planned dose will be set at an appropriate value below 0.8 mSv per day. If the daily planned dose for any worker is exceeded, a working situation confirmation is conducted, and a work management review is required.

Dose assessment methodologies for external and internal doses are in place and TEPCO benefits from the implementation of optimization of protection and the use of dose constraints for the radiation protection of workers in addition to their own long-term operational experience as a member of the international nuclear community. TEPCO effectively utilizes safety measures such as target values, daily dose follow-ups, and work permits related to workplace characteristics (including ALPS facilities and equipment). The Task Force noted that optimization is an obligation of means, and not an obligation of results in the sense that the result of optimization depends on processes, procedures, and judgements and is not a given value of dose or exposure. The result of optimization depends on processes, procedures, and judgements and is not represented by a given value for exposure. Therefore, the Task Force highlighted the conceptual difference of dose constraints specific to occupational radiation protection and notes that dose constraints are set separately for each source under control, and they serve as boundary conditions in defining the range of options for the purposes of optimization of protection and safety. This is consistent with GSR Part 3, Para 1.23. While the objectives of the use of dose constraints for controlling occupational exposure and public exposure are similar, the dose constraints are applied in different ways. For occupational exposure, the dose constraint is a tool to be established and used in the optimization of protection and safety by the person or organization (TEPCO, in this case) responsible for a facility or an activity.

TEPCO informed the Task Force that individual dose records at FDNPS are registered and stored in TEPCO’s Personal Dose Control System for both TEPCO employees and contractor workers and transferred in a routine basis to the system of Radiation Dose Registration Center for Workers. The Radiation Dose Registration Center for Workers centrally manages not only the exposure dose records at FDNPS, but also the exposure dose records of all nuclear facilities in Japan. The record keeping period for FDNPS is set by TEPCO at 150 years, and this applies at all activities at FDNPS, including those involving ALPS facilities and equipment.

(c) Summary and Follow Up

The Task Force is able to confirm that TEPCO has a reliable and sustainable radiation protection programme with the necessary commitment and ownership. The Task Force observed clear evidence of self-regulation by TEPCO for an advanced design and implementation of occupational exposure control measures and monitoring arrangements related to the operation of ALPS facilities and equipment.

The Task Force emphasized that it is essential to maintain a reliable workforce for the operation of ALPS equipment and facilities associated with planned discharges with necessary arrangements for the radiation protection of workers (long-term planning, e.g., 30 years) and encourages TEPCO to consider issuing an internal report on implemented radiation protection measures of the first-generation ALPS

(existing ALPS), including lognormal distribution of occupational exposure data for external and internal exposures of TEPCO workers and contractors.

Assuming long-term operation, the Task Force encourages TEPCO to consider establishing an internal mechanism for the reassessment of ALPS facilities and equipment on a periodic basis while taking into account the evolution of the radiological conditions in the relevant areas and during operation in the future. Long term monitoring by TEPCO and operation specific inspection of ORP arrangements is considered essential for the sustainable operation of ALPS.

APPENDIX I. APPLICABLE IAEA INTERNATIONAL SAFETY STANDARDS

This appendix contains a list of the IAEA International Safety Standards applicable to radioactive discharges in the environment.

Section	Safety Standard	Paragraphs
II.1. Crosscutting requirements and recommendations	GSR-Part 3	1.7, 1.8, 1.32, 1.33–1.35, 2.12, 2.39, 2.40, 3.5, 3.9, 3.13, 3.15(c–f, j), Req. 29, 3.119, 3.120(a, c–d), 3.121, Req. 30, Req. 31, 3.131(c–f)
	GSG-9	5.35(d)
	GSG-10	5.7
II.2. Characterization of discharge and source term	GSG-9	5.13(b), 5.20, 5.21
	RS-G-1.8	5.12(a, b), 5.15, 5.18–5.20, 5.22
II.3. Safety related aspects of systems and processes for controlling discharges	GSR-Part 3	Req. 13, 3.29–3.31, 3.32(a–d), 3.33(a, b, d), 3.34, 3.122, 3.127(d)
II.4. Radiological Environmental Impact Assessment (REIA)	GSR-Part 3	3.123(c), 3.124(a), 3.126(a, c, d)
	GSG-9	5.13(d, e), 5.22, 5.24, 5.43, 5.44, 5.46, 5.48, 5.51–5.58
	GSG-10	4.2–4.5, 4.9, 4.13, 5.2, 5.4, 5.6, 5.8, 5.9, 5.11–5.17, 5.19, 5.20, 5.22–5.26, 5.27(a–i), 5.30, 5.32–5.34, 5.36, 5.37, 5.43–5.81, 6.2–6.7
II.5. Regulatory control and authorization of discharges	GSR-Part 3	1.7, 1.15, 1.17, 1.22, 1.23, 1.25, 1.28, 3.22–3.28, 3.120, 3.123(a), 3.124(b), 3.126, 3.132(a, b, d, e), 3.133, 3.134
	GSG-9	5.1, 5.2, 5.5, 5.8, 5.9, 5.13(a, c, f, g), 5.14–5.18, 5.23, 5.25, 5.26, 5.30(b–e), 5.31–5.34, 5.35(c, e–g), 5.36, 5.39–5.42, 5.50, 5.51, 5.59–5.62, 5.66–5.69, 5.73, 5.74, 5.76, 5.82, 5.99–5.101
	GSG-10	4.11, 5.29, 5.38–5.42
II.6. Source and environmental monitoring programmes	GSR-Part 3	Req. 14, 3.37, 3.38, 3.127(f–g), Req. 32, 3.135(a, c–f), 3.137(a–e, g, h)
	GSG-9	5.13(b), 5.23, 5.74–5.76, 5.78–5.81, 5.84
	RS-G-1.8	5.1–5.3, 5.5, 5.6, 5.8, 5.9, 5.11, 5.12(c–i), 5.13, 5.16–5.18, 5.21, 5.23–5.30
II.7. Involvement of interested parties	GSR-Part 3	3.124(c)
	GSG-9	5.99–5.102

Section	Safety Standard	Paragraphs
II.8. Occupational Radiation Protection	GSR-Part 3	1.17, 1.22–1.24, 1.26, 2.35, 2.40(b), 2.41(b), 3.19, 3.26, 3.28, 3.34–3.38, 3.40, 3.42–3.44, 3.47, 3.68–3.71, 3.73–3.75, 3.76(a, d, e), 3.78, 3.79, 3.87–3.110
	GSG-7	2.9–2.13, 2.15, 2.16, 2.18, 2.19, 3.49–3.52, 3.60–3.66, 3.75–3.88, 3.90–3.110, 3.112–3.120, 3.122, 3.129, 3.132, 3.133–3.139, 3.141–3.146, 3.149, 3.150, 3.151, 10.1–10.6, 10.8, 10.9, 10.11–10.24, 10.28

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- [10] <https://www.tepco.co.jp/en/decommission/progress/watertreatment/index-e.html>
- [11] https://www.iaea.org/sites/default/files/report_1_review_mission_to_tepco_and_meti.pdf

III. Part III – Annexes

ANNEX I. LIST OF REVIEW TEAM MEMBERS

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- Gaku SATO Manager
- Katsuhisa MATSUZAKI Team Leader

ANNEX III. MISSION AGENDA
Second Review Mission to METI/TEPCO
14-18 November 2022

Monday 14 November 2022 (at METI HQ)	
09:30 – 10:00	Opening Session
10:00 – 12:30	Topic 2, Topic 4, Topic 5, Topic 6
12:30 – 14:00	Lunch
14:00 – 17:30	Topic 2, Topic 4, Topic 5, Topic 6

Tuesday 15 November 2022 (at METI HQ)	
09:30 – 12:30	Topic 2, Topic 4, Topic 5, Topic 6
12:30 – 14:00	Lunch
14:00 – 15:00	Topic 1, Topic 3, Topic 7
15:00 – 17:30	Topic 2, Topic 4, Topic 5, Topic 6

Wednesday 16 November 2022 (at Fukushima)	
09:30 – 12:30	Travel to Fukushima Daiichi Nuclear Power Station
12:30 – 13:30	Lunch
13:30 – 17:30	Technical visit to Fukushima Daiichi Nuclear Power Station

Thursday 17 November 2022 (at Fukushima)	
09:30 – 12:30	Topic 8
12:30 – 14:00	Lunch
14:00 – 17:30	Topic 8 and any other business
Evening	Travel back to Tokyo

Friday 18 November 2022 (at METI HQ)	
09:30 – 12:30	Task Force Internal Meeting
12:30 – 13:30	Lunch
13:30 – 15:00	Wrap Up Meeting
16:00 – 17:00	IAEA Press Conference

- **Topic 1 – Crosscutting Requirements**
- **Topic 2 – Characterization of Source Term/Discharge**
- **Topic 3 – Safety Related Aspects of Systems and Processes**
- **Topic 4 – Radiological Environmental Impact Assessment**
- **Topic 5 – Regulatory Control and Authorization**
- **Topic 6 – Source and Environmental Monitoring Programmes**
- **Topic 7 – Interested Parties**
- **Topic 8 – Occupational Radiation Protection**

